CURRENT AND INPUT VOLTAGE SENSE CIRCUIT FOR INDIRECTLY MEASURING REGULATOR CURRENT

BACKGROUND

[0001] Technical Field

[0002] Embodiments described herein are related to the field of voltage regulation for integrated circuits, and more particularly to the measurement of voltage regulator current.

[0003] Description of the Related Art

[0004] Computing systems may include multiple integrated circuits, each of which may include different circuits, such as, a radio frequency transceiver, for example. Such integrated circuits may employ different power supply voltage levels to perform their respective functions. Computing systems may employ one or more voltage regulator units to generate the needed power supply voltage levels.

[0005] Each voltage regulator unit may employ a combination of active and passive circuit elements to generate a desired voltage level from a reference voltage level. In some computing systems, such as, cellular telephones or table computers, a rechargeable battery may provide the reference voltage. In other computing system, the reference voltage level may be generated from an alternating current (AC) line voltage level.

[0006] Some computing systems may include a system-on-a-chip (SoC) which may integrate different functional units into a single integrated circuit. Each functional unit may employ a different power supply voltage level. In such cases, a Power Management Unit (PMU) may be used in conjunction with multiple voltage regulator units to generate the desired power supply voltage levels for the SoC, as well as, adjust the power supply voltage levels dependent upon performance or thermal characteristics of the computing system.

SUMMARY OF THE EMBODIMENTS

[0007] Various embodiments of a current monitoring unit are disclosed. Broadly speaking, a circuit and a method are contemplated in which a counter unit may be configured to receive a signal from a Power Management Unit (PMU). The signal may include a plurality of pulses, and the counter unit may be further configured to determine a number of pulses received during a predetermined period of time. A pulse sample unit may be configured to receive the signal from the PMU and determine a duration of a given one of the pulses received. Circuitry may be configured to determine a value of an average current flowing through an inductor included in the PMU dependent upon the number of pulses and the duration of the given pulse.

[0008] In another embodiment, in order to determine the value of the average current through the inductor, the circuitry may be further configured to multiply a value of a power supply coupled to the PMU by an intermediate value. The intermediate value may be dependent upon the duration of the given pulse, and at least one constant.

[0009] In another non-limiting embodiment, the at least one constant includes a constant of proportionality between a first value of current through the inductor and the value of the power supply coupled to the PMU. In a further embodiment, the circuitry may be further configured to determine a value of the at least one constant during a calibration mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The following detailed description makes reference to the accompanying drawings, which are now briefly described.

[0011] FIG. **1** illustrates an embodiment of a computing system.

[0012] FIG. **2** illustrates an embodiment of system-on-a-chip.

[0013] FIG. **3** illustrates an embodiment of a pulse analysis unit.

[0014] FIG. **4** illustrates an embodiment of a voltage regulator unit.

[0015] FIG. **5** illustrates a simplified schematic of a voltage regulator unit.

[0016] FIG. **6** illustrates example waveforms associated with the operation of a voltage regulator unit.

[0017] FIG. **7** illustrates a flow diagram depicting an embodiment of a method for measuring regulator current.

[0018] While the disclosure is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the disclosure to the particular form illustrated, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present disclosure as defined by the appended claims. The headings used herein are for organizational purposes only and are not meant to be used to limit the scope of the description. As used throughout this application, the word “may” is used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Similarly, the words “include,” “including,” and “includes” mean including, but not limited to.

[0019] Various units, circuits, or other components may be described as “configured to” perform a task or tasks. In such contexts, “configured to” is a broad recitation of structure generally meaning “having circuitry that” performs the task or tasks during operation. As such, the unit/circuit/component can be configured to perform the task even when the unit/circuit/component is not currently on. In general, the circuitry that forms the structure corresponding to “configured to” may include hardware circuits. Similarly, various units/circuits/components may be described as performing a task or tasks, for convenience in the description. Such descriptions should be interpreted as including the phrase “configured to.” Reciting a unit/circuit/component that is configured to perform one or more tasks is expressly intended not to invoke 35 U.S.C. §112, paragraph (f) interpretation for that unit/circuit/component. More generally, the recitation of any element is expressly intended not to invoke 35 U.S.C. §112, paragraph (f) interpretation for that element unless the language “means for” or “step for” is specifically recited.

DETAILED DESCRIPTION OF EMBODIMENTS

[0020] A system on a chip (SoC) may include one or more functional units, such as, e.g., a processor, which may integrate the function of a computing system onto a single integrated circuit. Some functional units may be designed using a full-custom design methodology, while other functional units may be implemented using logic synthesis and